Internet Technology Outlook: From Communication to Storage and Cognitive Computing

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CCS Concepts: • **General and reference** → **Cross-computing tools and techniques**;

Additional Key Words and Phrases: Communication, storage, cognitive computing, Internet technology

ACM Reference format:

Ling Liu. 2020. Internet Technology Outlook: From Communication to Storage and Cognitive Computing. *ACM Trans. Internet Technol.* 20, 1, Article 1 (January 2020), 4 pages.
<https://doi.org/10.1145/3378661>

ACM Transactions on Internet Technology (TOIT) is the flagship ACM transaction journal dedicated to featuring advancements in research and development of Internet technology. I became the editor-in-chief of *TOIT* in January 2019.

In 2019, we celebrated the 50th anniversary of the Internet. The **Internet** is a network of computer networks connecting computing servers and computing clients across geographical boundaries all over the world. In its first 30 years, the **Internet technology** grew into the dominating cyber communication technology platform. In the most recent 20 years, Internet technology continued to evolve, enabling and enhancing human-to-machine communication (H2M), human-to-human communication (H2H), and machine-to-machine communication (M2M). This evolution started from communication technology and expanded and continues to advance with storage and cognitive computing technologies at both the Edge of the Internet and in the core Clouds of the Internet.

(1) **Starting Point: Internet as a communication technology platform.**

Since the birth of ARPANET in 1969, the Internet has grown to be a dominating communication technology platform through many revolutionary advances. Here are some example milestones:

- In 1974, Telenet became the first commercial version of ARPANET with the first Internet Service Provider (ISP);
- In 1979, Usenet was launched for hosting news and discussion groups, creating the first appearance of “social network”;
- In 1981, an NSF grant was made for establishing the computer science network (CSNET) to provide network services to university computer scientists, which led to the release of NSFNET online in 1986, connecting supercomputer centers with a network of 2K computers;

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1533-5399/2020/01-ART1

<https://doi.org/10.1145/3378661>

- In 1982, the Transmission Control Protocol (TCP) and Internet Protocol (IP) emerged as the TCP/IP protocol suite for ARPANET, making ARPANET the first packet switching networks, enabling network communication over a shared network;
- In 1991, the World Wide Web was introduced by CERN, based on the development of HTML and URL by Time Berners-Lee and his colleagues at CERN;
- In 1993, the first Web browser, called Mosaic, was born, followed by Netscape Communication in 1994, the birth of Yahoo! in 1995, Netflix in 1997, Google in 1998, and Napster in 1999—the first peer-to-peer music-file sharing system.

The Internet today represents a standard form of communication. From the Internet Fact and Statistics data sheet (<https://hostingfacts.com/internet-facts-stats/>), more than 4B users were connected to the Internet in 2019. People use the Internet to communicate with each other anytime and anywhere through social networks (e.g., Facebook, Twitter) and decentralized machine-to-machine communication services (e.g., Skype, WebEx) through VoIP. People use the Internet to exchange information, to get 24-hour access to online entertainment such as music and streaming videos, and to order or deliver commercial and public services.

The provisioning of the Internet as a communication platform free of charge has fueled many innovations that have made transformative impacts on business, science, and technology development. Today, wireless Internet is the dominating form for Internet connectivity. When the wireless connectivity becomes intermittent and the network bandwidth fails to meet the required speed and capacity for real-time communication, it can cause operational interruptions detrimental to mission-critical decision making. Thus, in addition to continuing the provisioning of free Internet, another important technical challenge is to ensure the Internet remains a high-performance communication platform with desired efficiency and reliability. The software-defined networks and the 5G network for seamless integration of advanced cellular networks with fast wireless networks are representing the next generation of Internet technology towards guaranteeing reliable and high-speed Internet access.

(2) **Maturity: Internet as a data-storage technology platform.**

As Big Data and information digitization continue to gain popularity in business, science, and governments, the Internet has also become largely a distributed database that is operational 24/7 and can be accessed from anywhere. Information and data are transmitted and transported on the Internet from its edge to the whole world in the form of text, audio, video, and photo-sharing via instant messaging, file sharing, document loading, and video streaming. Every day, according to Internet Fact and Statistics data, there are over 4M blog posts published on the Internet, over 500M tweets sent over the Internet, and over 5B searches made to Google. The number of remote Internet storage hosting services continues to grow, with Dropbox, Google Drive, and Microsoft OneDrive as popular representatives. On one hand, many existing Internet storage services can provide much larger storage space with the promise of Internet accessibility from multiple devices and locations. On the other hand, many of these Internet storage service providers are unable to guarantee the same quality of access as those provided by the local file system due to the technical difficulty of real-time automated update synchronization among multiple devices of a single user and the poor search capability for keyword-based file lookup. In short, a number of open challenges still need solutions towards making the Internet one of the best storage technology platforms.

(3) **Impact: Internet as a cognitive computing technology platform.**

Fueled by Machine Learning (ML), Artificial Intelligence (AI), and Internet of Things (IoT), pay-as-you-go Cloud computing service providers and service consumers have become the prime users

that leverage Internet technology as a cognitive computing platform, which delivers computing as a service from hardware infrastructure, middleware software and application software hosting, to information acquisition and mining for decision makers.

The most visibly successful examples of Internet-enabled applications and services include: salesforce.com in 1999, Amazon Web Services in 2002, the release of Amazon Elastic Compute Cloud Service in 2006, Google Apps in 2009, and Microsoft Azure in 2010, marking the turning point of pay-as-you-go Cloud computing services. At the same time, we also witnessed the birth of MySpace and Skype in 2003, Facebook in 2004, YouTube in 2005, Twitter in 2006, and many more social networks and social media technology, which enable people-to-people communication and connectivity through the advancement of Internet technology. Furthermore, we have witnessed the transformation of the Mobile and Wireless Internet from the introduction of the iPhone in 2007. The continued evolution of smart phones, wireless laptops, and computers with new services, such as Airbnb in 2007, Uber in 2009, and Lyft in 2012, have marked the success of computing resource sharing through the Cloud with mobile and wireless Internet.

In recent years, the continued advances in wireless networking technology and sensor technology have fueled the development and deployment of next-generation wireless Internet and 5G technology, enabling the rapid growth of smart planet, Internet of Things (IoT), self-driving vehicles, and smart city initiatives and investments. With the success of IBM Jeopardy in 2011 and Google AlphaGo in 2015, big-data-powered ML and AI have invigorated the deep learning innovations in business, science, and engineering, exemplified by cyber manufacturing and digital healthcare. With the blossoming of software frameworks for ML and AI as a service, the Internet is once again evolving from transmitting information and data into a distributed **cognitive computing technology platform** for capturing, acquiring, and mining geographically distributed data and information sources, deriving deep insight, embracing and integrating AI with human intelligence at the Edge and in the Cloud of the Internet.

To meet the demand of our readership, the scope of *ACM Transactions on Internet Technology (TOIT)* is also expanding. It will cover new trends and a broader range of Internet technology towards advancing the Internet as communication, storage, and cognitive computing technologies as well as their corresponding platforms. In addition, *TOIT* introduced the vision column in summer 2019, aiming to feature articles that describe blue-sky ideas and grand research visions of future Internet technology as well as novel Internet applications and systems. The inaugural vision column will appear in the first issue of *TOIT 2020* with two vision articles, both of which have leading researchers as the principal authors. Furthermore, in 2019, *TOIT* recruited 12 new associate editors and a new information director, Emre Gursay from Georgia Institute of Technology, to handle *TOIT* Website development. Here is a brief introduction to the 12 new associate editors:

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In conclusion, I would like to take this opportunity to thank all of the editorial board members and all reviewers for their contributions as volunteers. My sincere appreciation also goes to Ms. Laura Lander and Ms. Stacey Schick from ACM, as well as Ms. Arriane Bustillo from SPI-global, for their excellent support and services to the *TOIT* paper submission, review, and publication workflow management. Furthermore, I would like to encourage researchers in academia and industry to submit your top-quality work to *TOIT* and encourage all our past, present, and future readers to share with us your feedback and suggestions.